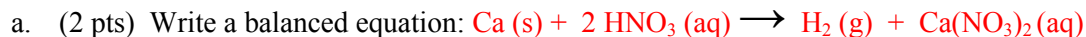


Exam IV – Chapters 8, 9, & part of 11

Circle your best answer and show work if you want to receive partial credit!

1. (10 pts) When 20.5904 g of solid calcium reacts with 250.0 mL of 2.50 M nitric acid at 23.2°C and 788 torr, hydrogen gas is evolved according to the following equation. The vapor pressure for water at 23.2°C is 20.26 torr.



- b. (8 pts) Calculate the volume, *in mL*, of hydrogen gas produced. $P_{\text{H}_2} = P_{\text{total}} - P_{\text{H}_2\text{O}} = 788 \text{ torr} - 20.26 \text{ torr} = 768 \text{ torr}$

$$\frac{20.2904 \text{ g Ca} (1 \text{ mol Ca}) (1 \text{ mol H}_2)}{(40.08 \text{ g}) (1 \text{ mol Ca})} = 0.5137 \text{ mol H}_2 \qquad P_{\text{H}_2} = 768 \text{ torr} = 1.01 \text{ atm}$$

$$\frac{250.0 \text{ mL} (1 \text{ L}) (2.50 \text{ mol HNO}_3) (1 \text{ mol H}_2)}{(1000 \text{ mL}) (1 \text{ L}) (2 \text{ mol HNO}_3)} = 0.3125 \text{ mol H}_2 \text{ * LR} \qquad V = \frac{nRT}{P} = \frac{(0.3125 \text{ mol})(0.08206)(296.2 \text{ K})}{(1.01 \text{ atm})}$$

2. (3 pts) A gas in a closed container is heated from room temperature to 100°C. Assume that the volume of the container remains unchanged. According to the kinetic molecular theory, the

- a. gas has increased in weight.
b. individual molecules of the gas have increased in size.
c. average distance between molecules has increased.
d. pressure on the sides of the container has decreased.
e. average velocity of the molecules has increased.

3. (10 pts) Please determine if the following statements are true or false.

T / **F** a. In the ideal gas law, $PV = nRT$, temperature and pressure are inversely related.

T / F b. When you touch an ice cube, your hand loses heat and the ice cube gains heat so it feels cold.

T / **F** c. Standard state for a reaction is 0°C, 1 atm, and 1 molar concentration of all reactants.

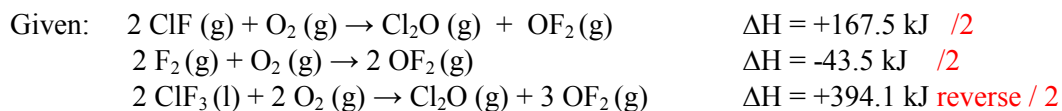
T / F d. For endothermic reactions, the energy/heat of the products is greater than the energy/heat of the reactants.

T / F e. The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas (at given temp.).

4. (8 pts) A steel bottle contains 1.75 L of krypton gas at STP. What is the final pressure if the temperature is changed to 203°C and the volume increases to 4.25 L?

- a. 1.39 atm
b. 546 atm
c. 0.718 atm
d. 13.0 atm

5. (8 pts) Find the ΔH°_f for ClF_3 , a fluorinating agent once used to produce uranium compounds in nuclear fuels:



- a. **-135.1 kJ**
b. +183.1 kJ
c. +518.1 kJ
d. -270.1 kJ

6. (3 pts) Which arrangement shows gases in order of **increasing** average molecular speed at 25°C.
- Kr (g) < Cl₂ (g) < CO₂ (g) < CH₄ (g)
 - CH₄ (g) < CO₂ (g) < Cl₂ (g) < Kr (g)
 - Kr (g) > Cl₂ (g) > CO₂ (g) > CH₄ (g)
 - CH₄ (g) > CO₂ (g) > Cl₂ (g) > Kr (g)
7. (3 pts) Ethyl alcohol is produced by the fermentation of glucose:
- $$\text{C}_6\text{H}_{12}\text{O}_6 (\text{l}) \rightarrow 2 \text{C}_2\text{H}_5\text{OH} (\text{l}) + 2 \text{CO}_2 (\text{g}) \quad \Delta\text{H}^\circ = -82.0 \text{ kJ}$$
- The reaction is endothermic so heat is absorbed.
 - The reaction is endothermic so heat is released.
 - The reaction is exothermic so heat is absorbed.
 - The reaction is exothermic so heat is released.**
8. (8 pts) Calculate the amount of heat evolved if 12.785 g of glucose, C₆H₁₂O₆, is fermented according to the equation in problem number 7.
- 1424 kJ
 - 1260 kJ
 - 753 kJ
 - 671 kJ
9. (12 pts) Circle the appropriate answer for each when placed in a beaker all ready containing CH₃CH₂OH. **Polar**
- | | | | | |
|--|----------------|------------------|-----------------|-------------------|
| a. I ₂ (s) | soluble | insoluble | miscible | immiscible |
| b. CH ₃ Cl (l) | soluble | insoluble | miscible | immiscible |
| c. AgNO ₃ (s) | soluble | insoluble | miscible | immiscible |
| d. CH ₃ CH ₂ NH ₂ (l) | soluble | insoluble | miscible | immiscible |
| e. C ₈ H ₁₈ (l) | soluble | insoluble | miscible | immiscible |
| f. CCl ₄ (l) | soluble | insoluble | miscible | immiscible |

10. (8 pts) Draw the solvation of one formula unit of KBr in water.

K⁺ surrounded by water with O towards ion Br⁻ surrounded by water with H towards ion

11. (3 pts) 0.50 moles of CO₂ and 0.75 moles of O₂ are combined into a closed container and the final pressure of the mixture is measured to be 2.50 atm. Which one of the following statements is true regarding this system?
- Both gases will have the same partial pressures.
 - CO₂ will have a larger partial pressure than O₂.
 - O₂ will have a larger partial pressure than CO₂.**
 - The partial pressures cannot be determined from this information.
 - The partial pressure of O₂ will be 1.00 atm.
12. (8 pts) For the following chemical or physical changes, determine if each process is endothermic or exothermic:
- | | <u>Enthalpy Change</u> | |
|--------------------------------|------------------------|--------------------|
| a. Ice cream melting | Exothermic | Endothermic |
| b. Rubbing alcohol evaporating | Exothermic | Endothermic |
| c. Water vapor condensing | Exothermic | Endothermic |
| d. Combustion of propane gas | Exothermic | Endothermic |

13. (8 pts) Assume that 50.0 mL of 0.200 M CsOH and 75.0 mL of 0.400 M H₂SO₄ are mixed in a calorimeter. The solutions start out at 23.50°C, and the final temperature after the reaction is 46.78°C. The densities of the solutions are all 1.00 g/mL and the specific heat of the mixture is 4.18 J/(g°C). What is the enthalpy change for the neutralization reaction? $\text{CsOH (aq)} + \text{H}_2\text{SO}_4 \text{ (aq)} = 2 \text{H}_2\text{O (l)} + \text{Cs}_2\text{SO}_4 \text{ (aq)}$

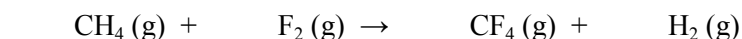
$$50.0 \text{ mL CsOH} (1 \text{ L}/1000 \text{ mL})(0.200 \text{ mol}/1 \text{ L})(2 \text{ mol water}/2 \text{ mol CsOH}) = 0.0100 \text{ mol water}$$

$$75.0 \text{ mL H}_2\text{SO}_4 (1 \text{ L}/1000 \text{ mL})(0.400 \text{ mol}/1 \text{ L})(2 \text{ mol water}/1 \text{ mol H}_2\text{SO}_4) = 0.0100 \text{ mol water}$$

$$q = (125 \text{ g})(4.18 \text{ J/g}^\circ\text{C})(46.78 - 23.50) = 12163.8 \text{ J} = 12.2 \text{ kJ}$$

$$\Delta H = -q/n = -12.2 \text{ kJ} / 0.0100 \text{ mol} = -1220 \text{ kJ}$$

14. (8 pts) Use the given average bond dissociation energies to estimate ΔH for the reaction of methane, CH₄ (g), with fluorine:



$$[(4 \times 410 \text{ kJ/mol}) + (2 \text{ mol} \times 158 \text{ kJ/mol})] - [(4 \text{ mol} \times 450 \text{ kJ/mol}) + (2 \text{ mol} \times 436 \text{ kJ/mol})]$$

$$= 1960 \text{ kJ} - 2670 \text{ kJ} = -710 \text{ kJ}$$

Bond	E_{BDE} , kJ/mol
C-F	450
C-H	410
F-F	158
H-H	436

Extra Credit: (6 pts)

One type of alcohol analysis determines the presence of ethanol (C₂H₅OH) by titration with K₂Cr₂O₇:



In Arizona, a driver is legally impaired if his/her blood alcohol level is 0.08% or higher. A driver suspected of DUI violation submitted a 5.00 g blood sample, which required 21.56 mL of 3.50 × 10⁻³ M K₂Cr₂O₇ (aq) for complete titration of the ethanol.

- a. Calculate the driver's blood alcohol content (mass/mass % of alcohol in the blood).

Hint: Mass/Mass % = (g solute / g total sample) × 100%

- b. Was the driver legally impaired? (Circle one) YES NO

**No credit for the answer if no work is shown!